A Comparison of Three Library Research Approaches with High School Science Students

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This paper is lovingly dedicated to the memory of Florence M. Gulden whose love of learning inspired me through this endeavor.

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CHAPTER I

INTRODUCTION

The Information Age has arrived, and today's students must learn to process the ever-growing amount of data available from a variety of sources. More information has been produced within the last three decades than in the last five millennia. In every 24 hour period, approximately 20,000,000 words of technical information are being recorded (Nelson, 1995). John Naisbett states in his book *Megatrends*, that some scientists report taking less time to conduct an experiment than finding out whether it has been done before (Naisbett, 1984). In order to keep up with a technologically advanced society, schools have joined the information explosion movement. Students routinely access a vast amount of information from print, CD-ROM and online databases, and the Internet. The Internet 's vast storehouse of information has exploded. According to Bharat and Broder (1998) of the Digital Systems Research Center, the World Wide Web has grown from about 125 million static pages in mid 1997 to 275 million in March of 1998. Search engines used to locate information are unable to keep up. Bharat and Broder also state that AltaVista, the largest search engine, only accesses 40 percent of these pages. While educators welcome such rich stores of knowledge, the challenge to change the way we prepare students to become better consumers of information is apparent. If students are only able to access less than half of the current information on the Web, educators must ensure that they are using the best sources among those located.

Statement of Purpose

Information literacy is defined by the American Library Association as "the ability to access, evaluate, and use information from a variety of sources" (ALA, 1997). This definition is consistent with *Goals 2000* and *SCANS* reports which suggest that information literacy is essential to preparing students for a technology rich workplace. Students who are able to access, use, and communicate effectively using technology will be be more effective workers.

Library Media specialists have been in the forefront of information literacy reform for many years. Since the publication of *Information Power* in 1988, library professionals have been changing the methods by which information skills have been taught. Several studies have been conducted over the years to determine the effect of library media programs on student achievement. A landmark study of school library media centers in Colorado in 1993 found that expenditures on library media collection and staff were one of the greatest predictors of academic achievement, and that the role of library media specialist as educator and collaborator was of particular importance (Lance, 1993). Subsequently, library media methods have evolved from teaching isolated access skills to a more curriculum-integrated research process approach. Biggs proposed that library skills taught in isolation without an authentic task were without merit (Biggs, 1979). A subsequent study conducted by Katsuko Hara that compared resource-based, non-integrated library skills, and no library skills instruction with elementary school children supports this theory.

Carol Kuhlthau, one of the pioneers of the research process, conducted significant research regarding the psychology and methods of successful researchers, and her model became the basis of later information seeking

models. Some of the more prominent are the *Pathways* (Follett) model developed by Marjorie Pappas and Ann Tepe, the *Dialogue* Method developed by Greg Byerly and Carolyn Brodie, *FLIPIT* by Alice Yucht and her students, and *Big Six Skills Information Problem-Solving*, currently the most popular model, developed by Michael Eisenberg and Robert Berkowitz. The *Big Six* skills include: defining the task, information seeking strategies, locating the information, accessing and using the information, synthesizing and presenting the information as prescribed in step one, and evaluating the process and the product. While the early work by Kuhlthau influenced these works, one of the major improvements of the later models is the focus on synthesis of the material selected and evaluation of the sources, the product, and the process itself.

Current educational library theory supports resource-based learning and problem-solving research process approaches as the best methods to develop information literacy, and while library media specialists are enthusiastic about this approach, they also experience problems, as well. Many teachers are reluctant to allow the time necessary to conduct effective library research. Additionally, some students are unmotivated to put forth the effort necessary to conduct thoughtful research. Furthermore, library media specialists are often frustrated with curriculum-integrated approaches because the classroom teacher is often in complete control of the design of the lesson, and they are often not included in the planning. Clearly, library media specialists need to be part of curriculum and information literacy planing in order to ensure that students receive adequate practice in this important skill (Pappas, 1998; Barron, 1998).

Problem Statement

Many students have achieved computer literacy, as evidenced by their ability to access, cut and paste, and assemble seemingly careful research from electronic sources. However, they may not have effectively learned to evaluate and synthesize the information they have found. While practitioners believe that the research process models are the best tools for developing information literacy, these have only recently been implemented, and require further testing to determine their effectiveness.

This study will compare the effectiveness of the *Big Six Skills Information Problem-Solving Model* with a modified process model and information access-only skills using high school science students completing a problem-solving research assignment. Souchek and Meier reported success using a process approach in biology classes at Doane College in Crete, Nebraska (Souchek and Meier, 1997). Criteria for assessment will be based upon the quality of the project, an analysis of the types, currency, accuracy, and number of sources cited in the bibliography portion of the students' project, as well as an attitude survey to be completed by the participants.

Hypothesis

Students who are taught to use the *Big Six Skills* method will demonstrate a better knowledge of information literacy and will have a more positive research experience than students who use a modified process model omitting the evaluation stage or who only receive instruction in where and how to access information.

Definition of Terms

1. Information literacy--the ability to access, evaluate, and use information from a variety of sources.
2. Constructivist theory--learning that builds upon what students already know and actively involves them in learning through a variety of sources, rather than learning a predetermined set of knowledge from a teacher or a text.
3. Resource-based learning--learning from a variety of resources.

Chapter II

REVIEW OF LITERATURE

Library media specialists have long been convinced of the importance of their role in the educational process of their students, but a 1993 Colorado study confirmed their value. Keith Lance's study sampled 221 of 1,331 public elementary and secondary schools, based upon those schools who responded to the Colorado 1989 *Survey of School Library Media Centers*, and whose students took either the *Iowa Test of Basic Skills* or the *Test of Achievement and Proficiency*. The study concluded that the size of the library media program, as indicated by the size of the staff and the collection is the best predictor of academic achievement, and that the instructional role of the media specialist shapes the collection and the instructional achievement of the students. The obvious limitations of the study are the use of standardized tests rather than a more authentic assessment of student achievement, and that the study makes no reference to the methods of library skills instruction (Lance, 1993).

A study of the effects of formal library skills instruction on elementary school students, conducted by Katsuko Hara, compared 300 fourth, fifth, and sixth grade students' performance on Ann Hyland's *Library Media Skills Test.* The study concluded that students who received resource-based methods performed better than the other groups, and that there was no measurable difference in the other two groups. The study also suggested that there was significant growth in acquisition of library media skills by sixth grade students among those who received resource-based instruction, while there was no difference among those who received non-integrated or no library skills instruction (Hara, 1998).

Further validation of the merits of information literacy taught within the framework of a resource-based problem-solving process approach comes from the *Goals 2000* and *SCANS* reports. Originally established by President Bush in 1990, a governor's task force led by Governor Bill Clinton proposed six national educational goals. Later officially signed into legislation by President Clinton in 1994, *Goals 2000* identifies goals that are a framework for strengthening our educational system. One of the goals deals directly with information literacy, encompassing critical thinking and learning to use varieties of information sources for lifetime learning. In 1992, a national panel of experts from 62 organizations comprising the National Forum for Information Literacy collaborated in a study of the National Educational Goals for the purpose of examining the outcome measures as a means of assessing information literacy. A series of recommendations followed the study, including the following: schools must provide a variety of materials for research, teachers and librarians must provide opportunities for practicing information literacy and problem-solving skills, and there should be increases in research and demonstration projects related to information literacy and its use (Progress, 1998).

Further study of available literature regarding library research skills and information literacy reveals a shift from definitions and justification of their merits to the development of specific models or methods for their acquisition. Using a constructivist theory, Carol Kuhlthau of Rutgers University conducted thorough research over the course of many years to lay the groundwork from which many others have followed. Her first study explored the research process of high school seniors and compared their experiences with psychologist George A. Kelly's theories on the feelings one experiences when encountering new information. Using observation, questionnaires, interviews, and journals to

gather information, she noted that, much like Kelly's theory, the students first experienced doubt and confusion when confronted with new information. The feelings escalated as the student found conflicting or confusing information, after which he either quit or formed a hypothesis that moved the process forward. At this point the student formed a focus and the confusion waned while interest in the topic increased (Kuhlthau, 1989). As a result of this study and the influence of Kelly's work, Kuhlthau identified the following stages of the information seeking process: task initiation, topic selection, prefocus exploration, focus formulation, information collection, and search closure. After these stages are completed, the student begins to write the research document (Kuhlthau, 1985).

A subsequent study conducted four years later explored the changes in perception of the research process by 20 of the original 24 subjects. Given the same questionnaire after four years of college, the students revealed that their perceptions of the research process had changed somewhat, actually matching Kuhlthau's model even more closely (Kuhlthau, 1989).

Kuhlthau's third study, consisting of further examination of selected case studies of the original subjects, revealed that the students did not strictly rely on a linear representation of the model, but moved through the various stages as necessary to form a focus (Kuhlthau, 1989). This recursive movement becomes important in development of later models.

Finding some validation of the original model over time with the same subjects, Kuhlthau sought to further validate her model with high, middle, and low achieving students. In addition to determining if middle and low achieving students experience the same process, she also wanted to know if the teachers' assessment of the product related to close adherence to the process model.

Teachers, in addition to grading the papers, looked at quantity of sources and presence of focus within the document. While data from the low achieving subjects was incomplete and could not be analyzed, examination of the data from the middle and high achieving students revealed no significant difference in process, although the high achieving students received higher grades. However, a positive correlation between increase in confidence and presence of focus was noted (Kuhlthau, 1991).

The fifth study in the series sought further validation of the information seeking model within a wider sample of library users. Kuhlthau administered a process survey similar to that used in the previous studies with 385 users from academic, school, and public libraries. Each subject was surveyed at initiation, midpoint, and closure. Her findings revealed a similar process approach among all library users with the following differences: college students reported feeling more confidence at closure than high school users, while public library users were more confident at the outset . Furthermore, in this study, only about 50% of the subjects seemed to form a clear focus from their research. Kuhlthau concluded that further verification of the model across disciplines and between expert and novice users was indicated (Kuhlthau, 1991).

Kuhlthau further studied library media programs in order to identify which programs were successful, and to determine the primary inhibitor and enablers for successful implementation. Stressing the importance of the constructivist theory and that the value of any research process is the interpretation of the information process, Kuhlthau created training institutes in order to teach her process model to library media specialists across the United States, Canada, and Sweden, and to train them in effective methods of guiding their students in the process approach. Participants who joined in the implementation phase of

the research were surveyed six months later regarding their own participants and assessment of their own process implementation.

Kuhlthau noted some inhibitors to successful programs were time on task for students, lack of cooperation between library media specialist and teacher, and assignments that did not encourage a process approach (Kuhlthau, 1993).

An additional longitudinal case study of one such successful program identified several elements that enabled the process approach. Kuhlthau concluded that the program had a successful library program already in place, there was strong cooperation between teachers and the library media specialist who set aside much planning time, and that the team had a positive attitude about the process approach and what activities supported the process. She further noted that the teams emphasized activities in the early stages to guide students through the process, and encouraged students' emotional attachments to their projects. Finally, she observed that the administration was very supportive of the process approach (Kuhlthau, 1993).

Using Kuhlthau's model as a springboard for her exploratory research on the impact of gender on information seeking, Tracey Burdick analyzed differences in experiences by gender and research styles, leading to the emergence of involvement as a major information-seeking component. Levels of focus formulation were identified and tied to involvement to form a matrix of "Information Search Styles." Burdick studied the information seeking actions, thoughts, feelings, and focus formulation of 80 upper-level high school students. Having constructed a hypothetical model of nine information seeking style categories to describe her subjects based upon their level of focus, Burdick identified Lost and Wanderers, Tourists, and Navigators. She further identified levels of involvement as Reluctant, Detached, and Involved (Burdick, 1996).

Her matrix is made up of the various combinations of level of focus and involvement. While Burdick's study revealed some implications for further gender research, her insight into search styles and involvement were of particular interest. Overall, Burdick found that 36 of her students understood the task and were highly focused, and 18 of this group were also involved in their topic. The others were spread throughout the matrix. Burdick offered the following conclusions: many of the users thought the most important task was gathering information rather than focus formulation, and even the most successful and involved did not feel confident at the conclusion. Further implications from this study reveal that while focus formulation is an important emphasis, library media specialists and teachers must also encourage and try to increase students's feelings of enjoyment during research (Burdick, 1996).

Burdick used qualitative data to ascertain from her students what leads to involvement and increased pleasure during the research process. Basing her conclusions upon responses to surveys from her earlier study, Burdick offered the following suggestions. Burdick believes that giving students a choice in selection of topics is essential, as well as making sure the assignment is meaningful and is an authentic task rather than just finding the answer to a question. Allowing the students to include their own voice and expression is also important. Allowing sufficient time for library research and conference time with their teachers, as well as careful guidance from the library media specialist seemed to be crucial to having a positive library experience. Some students reported some bad experiences with library staff that seemed to negatively affect their attitude toward future library research activities. Furthermore, she noted that anxiety plays a role in whether students become confident and comfortable with their research. Technology can be a factor in alleviating some

of the anxiety for some students, while it can be a source of anxiety for others. Collaboration and peer tutoring helped some students become more comfortable with technology. Finally, Burdick noted that acknowledgement of the anxiety-provoking elements of the research process may help some students become more satisfied and comfortable with information seeking (Burdick, 1998).

Library and academic personnel are beginning to report the successful integration of information processing skills within the curriculum. At Doane College in Crete, Nebraska, Russell Souchek and Marjorie Meier reported great success with their information literacy and science integration project. Students were given instruction in a resource-based process approach during which the students integrated library research with their hands-on laboratory work, culminating in a research document. Despite the extra time involved, Souchek and Meier were very pleased with the results and recommended its implementation across the curriculum (Souchek and Meier, 1997). However other librarians report very different results.

Ann Roselle, reference librarian at the University of Botswana, realized that despite the careful integration of information literacy skills into the nursing curriculum, the nursing students were still uncomfortable conducting their own research. Analysis of student surveys and works cited pages from their research papers confirmed acquisition of information seeking skills, but Roselle's observations and open-ended questioning gave valuable insight into the frustrations of her students and recommendations for additional evaluation of information literacy skills programs (Roselle, 1997).

CHAPTER III

METHODOLOGY

Subjects

The subjects of this study were eleventh and twelfth grade high school students enrolled in a Science Technology and the Environment course at Tecumseh High School. With a student enrollment of approximately 1100 students, Tecumseh High School is located in Clark County near New Carlisle, Ohio. The school is located in a rural area, and the students who attend Tecumseh are from several small communities and surrounding rural areas. Predominately Caucasian, the students come from a low to middle socioeconomic background. After completing Earth Science and Biology, students may enroll in the Science Tech course in order to fulfill a science requirement if they elect not to take Chemistry or Physics. As a result, the students enrolled in the course possess various levels of academic ability. Students enrolled in the Science Tech course were divided into three classes, scheduled periods three through five each day, with 27 students assigned to each class. The classes were randomly placed in a modified process (known in this study as Group A), a *Big Six* (known as Group B), and the control group (known as Group C). Students were told they were assisting in a research study, but no other details were given.

Experimenter

The study was conducted by Cynthia Gulden, Library Media Specialist at Tecumseh High School. Gulden has seventeen years of experience in education including classroom teaching and library media. Jerry White, science instructor, provided the students, designed the problem solving assignment, and assisted in the teaching and evaluation process.

Serving as Chair of the Science Department at Tecumseh High School, White has twenty years experience as a classroom teacher.

Setting

All of the research process instruction took place in the Library at Tecumseh High School. The library maintains a collection of approximately 11,000 book titles and nearly 100 periodical titles. Recently automated, the library contains a total of thirteen computer research stations. All computers access the online catalog of library holdings and *InfoTrac*, a CD ROM periodical index and full text database of hundreds of periodical titles. In addition, nine of the computers also access a tower containing various CD ROM titles and are connected to the Internet via a fiber optic network. The library staff is comprised of one full time certified library media specialist and one library aide. Student aides are available to assist in providing periodicals and locating materials for patrons .

Upon completion of the research portion of the assignment, the students prepared three to five minute oral presentations with a visual aid using a problem-solving model which was demonstrated by the science instructor prior to the student presentations. The problem-solving model can be found in Appendix A. Student presentations were videotaped for later analysis by the instructors and evaluators.

Instruments

All participants in the study received a pretest of library and research skills developed by the experimenter. It was comprised of 20 multiple choice questions designed to determine the existing knowledge participants had in the following conceptual areas: citing sources, note taking, accessing various types

of sources, identifying primary and secondary sources, outlining, and key word searching. The Library Skills Pretest is found in Appendix B.

Additionally, all participants received a pretest comprised of science material to be taught in the Science Tech course. Teacher-generated, the test was comprised of 50 multiple choice questions, and is found in Appendix C.

Mary M. Jackson states that testing that reduces assessment to short questions and answers cannot reflect the complex mental process involved in information use (Kuhlthau, 1994). Alternate assessment, therefore, is more appropriate to fully evaluate the complex thinking skills required in the research process. Marjorie Pappas, former Coordinator of the Division of Library Media Studies at the University of Northern Iowa, states that authentic assessment for research process should include outcomes related to stages in a holistic process (Pappas, 1998). She further suggests rubrics developed by the teacher and or library media specialist are an appropriate method of authentic assessment (Pappas). The research projects of all participants were evaluated using a rubric designed by the experimenter. Scores were reflected using a holistic method. The rubric, found in Appendix D, is comprised of the following three areas: citations, content, and presentation. Prior to its use, the rubric was evaluated by a curriculum consultant and an experienced master teacher, and their recommendations were incorporated into the document.

Finally, the attitudes of all participants were evaluated using a likert-type survey to assess their attitudes and feelings regarding library research. Kuhlthau reported the importance of the attitude of the researcher throughout the research process (Kuhlthau, 1990). This survey was used to measure the attitudes of participants following research, and included six questions regarding attitudes or feelings experienced when conducting research.

Question seven was open ended to allow participants to further explain such feelings. The attitude survey is found in Appendix E.

Instructional Approach

The *Big 6 Problem Solving and Information Skills Model*, as well as a modified process model omitting the evaluation stages will be used for this research study. Randomly assigned, period three, known as Group A, received the modified process model instruction, period four, known as Group B, received the *Big 6 Problem Solving and Information Skills Model*, while period five, known as Group C received only location and access information.

Developed by Michael Eisenberg and Robert Berkowitz, the *Big Six* can be easily adapted for use in all grade levels and with all subject areas. Incorporating Bloom's taxonomy with the research process, the model addresses all cognitive domains, and stresses the higher level thinking skills of synthesis and evaluation. One of the important goals of the design is to allow students to move through the six stages in a linear fashion, or to stop for reflection and evaluation of the process, going back to any stage that needs more attention. Areas of concentration included the preparation of specific research questions and where to find such types of information, evaluating sources, reading for content and note taking, organization and adequate coverage of main ideas and supporting details, and evaluation of the product and process.

Students using the modified process model prepared questions, but were not led to evaluate their research findings. Both the *Big Six* and modified process experimental groups kept notes recording the steps of the process.

Students in Group C, serving as the control group, received information on how to locate, access, evaluate, and cite sources. They were asked to keep a folder of notes and the outline for the paper. They were allowed to work without much guidance or interference, although their notes were checked periodically.

All groups were given the same assignment. Students were given choices of topics relating to the problems encountered within park systems. They were to research problems and find possible solutions, then explain which was the most viable and why. Some examples of topics included: vandalism in parks, endangered species in parks, and the use of motorized vehicles in parks. Following research, all groups orally presented their findings using a common problem-solving model. All students were to complete and turn in a completed problem-solving outline, visual aid, and works cited page at the time of presentation. It should be noted that information for the topics researched was not always easy to find. In most cases, students had to employ logical keyword searching and thorough reading in order to make inferences and draw conclusions from the information they found in order to use the problem-solving model effectively.

Design

Since intact classes were used to conduct this research, a quasi-experimental design was used for this study. The Non-equivalent Control Group design was used in order to determine the library research skills and science knowledge of the students prior to and following the instruction, and to control for other variables. Figure 1 illustrates this design.

O X_1 O

O X_2 O

O X_3 O

Figure 1. Non-equivalent control group design for three experimental conditions.

Procedures and Data Collection Methods

Students in all three groups were given both an environmental science and library research pretest. Both pretests were administered in the classroom by the science instructor. Following completion of these preliminary items, the students received an introduction to the topics of their research. Students were permitted to select the specific topics they preferred to research from a list provided by their science teacher. Students received instruction in the problem-solving model, and were given explicit information regarding requirements of the assignment. Students in Group A were instructed in the modified process model, using approximately five days total including library research and instruction. Students in Group B were instructed in the *Big Six Problem Solving Model*, incorporating six days for instruction and research, including a group discussion on evaluating their sources and the process. Group C used the same amount of time for research, with a total of four periods in the library. All groups received instruction in citing sources, primary and secondary sources, and discussed how the presentations would be evaluated. The chart in Appendix F will provide a clear explanation of the exact methods used for both

the experimental and control groups. Care was taken to ensure that students performed their own tasks, and teacher assistance was limited to guiding and coaching. Since the same teacher and library media specialist performed the same duties for all groups, uniformity and consistency was controlled. In addition to the specific steps of the *Big Six* research process, the experimental groups recorded all pertinent information (research questions, notes, outlines, and evaluations) in a research journal. The journal was inspected by the library media specialist at least twice during the research study for analysis of progress. Students in the control group maintained a folder of notes and outlines. This was periodically checked for further analysis. Students were permitted to work on the assignment on their own time, and the library media specialist announced times when the library would be open additional hours after school.

Students were randomly assigned to present during one of the four days allotted for presentations. They were required to present on the day assigned or take a zero. Students who were absent were required to present on the last day. Following completion of the assignment, the presentations for all groups were evaluated and the attitude survey was distributed and scored. The presentations were evaluated by the media specialist, classroom teacher, and Cindy Fisher, Curriculum Specialist for the Clark County Schools, using the rubric identified as Appendix D. Each student received a holistic score (from 1 to 5, with 5 being the highest) in each of three criteria components: Citations, Content, and Presentation. Each judge provided the raw score for each participant, and all judges' scores were averaged for the final assessment. Works Cited pages were copied scored for content analysis by the media specialist.

The attitude surveys were administered in the classroom by the media specialist and the classroom teacher. The students were instructed to label their class period at the top of the page. These were collected and placed in the envelopes by a student representative in each class.

Chapter IV

RESULTS

Data Analysis

The first step in data analysis was to analyze and compare the results of the science and library skills pretests in order to determine if there were any differences among the three groups regarding library skills or environmental science knowledge. Means and standard deviations were computed and compared.

The next step was to analyze the presentation scores for the students in each group. Scores for works cited, content, and presentation were collected for further analysis, and a composite score was computed for each student. The mean and standard deviation were recorded for each group. Group scores were computed twice, with the first computation including those students who did not complete the assignment (resulting in a score of zero). Group scores were computed again excluding those subjects who did not participate in the post assessment. This allows for closer analysis of the completed projects.

In addition to the analysis of the overall scores, special consideration was given to the works cited data for each student and each group. The works cited data was analyzed by type of source, and percentages per type were recorded for each group.

Next, the author's observation notes taken from the research sessions were analyzed, looking at the methods and attitudes of each group.

Finally, the attitude survey was analyzed to determine how the three groups felt about the research process. Six items on the likert-scaled survey ranged from a minimum value of one to a maximum value of five. The first three questions were worded in such a way that a positive response (strongly agree,

agree) would receive five or four points respectively, whereas the last three questions were worded in such a way that a negative response (strongly disagree, disagree) was ideal; the values were reversed for calculation and analysis. The results were scored as a whole and a mean and standard deviation for each group was recorded. Each question was analyzed separately, and percentages of positive, undecided, and negative responses were noted for each class. Question seven on the survey was open-ended, and allowed the participants to further explain their feelings at the beginning, during, and at the end of the research process. The survey is found in Appendix E. The comments listed by group appear in Appendix G. These, as well as observations recorded by the author, were used to assist in the interpretation of the results.

Pretest Results

Table 1 presents an analysis of the Science Tech pretest which reveals little difference among the groups in regard to prior knowledge of the science subject matter . With a possible score of 50, the mean of all classes was approximately 21. Analysis of the library research pretest showed slight differences in library skills among the three groups. All group scores reflected little knowledge of library research skills. Table 2 presents the means and standard deviations calculated for each group. With a possible score of 20, Group B scored the highest with a mean of 8.4, Group C was next with 7.8, and Group A was the lowest with a mean of 6.6.

Table 1

Mean and Standard Deviation of Environmental Science Pretest Results by Group.

Group	M	SD
A	21.24	4.7
B	21.35	4.6
C	21.04	4.1

Note. Maximum score = 50.

Table 2

Mean and Standard Deviation of Library Research Skills Pretest Results by Group.

Group	M	SD
A	6.64	2.6
B	8.42	3.1
C	7.88	2.6

Note. Maximum score = 20.

Presentation Results

Presentation Results

Student presentations were scored using rubrics found in Appendix D. The three evaluators' scores were averaged to determine the composite score for each student in each of the three areas evaluated, as well as a total score. Works cited scores were incomplete since some students did not complete a works cited page for evaluation. Table 3 shows the means and standard deviations for each group. This first computation shows that Group C performed the best on the post assessment presentations, with Groups A and B performing about the same. However, when scores were recalculated omitting the scores for those students who did not complete the assignment (excessive absences, suspensions, chose not to present), the results changed noticeably. Table 4 reveals that Group B scored highest with a mean score of 3.0, Group C was next with 2.8, followed by Group A with a mean of 2.6.

There are not significant differences among the scores to support the hypothesis that students in Group B would demonstrate a better knowledge of information literacy than students in Groups A or C. However, Roselle (1997) reported that statistical significance may not adequately indicate the educational significance of a method of library skills instruction, but that a multi method of qualitative analysis may provide more valuable information. Further qualitative comparisons are indicated to analyze how the groups performed.

Table 3

Mean and Standard Deviation of Problem Solving Presentation Composite Scores by Group (All Scores)

Group	M	SD
A	2.0	1.2
B	2.0	1.7
C	2.5	1.0

Note. Maximum score = 5.0. Includes scores of 0 for students who did not present.

Table 4

Mean and Standard Deviation of Problem Solving Presentation Composite Scores by Group (Scores of 0 Omitted)

Group	M	SD
A	2.6	0.7
B	3.0	1.2
C	2.8	0.7

Note. Maximum score =5.0. Scores of 0 for students who did not present omitted.

Works Cited Comparisons

Since evaluation of sources was part of the *Big Six* process model, the works cited pages were analyzed for each student. Unfortunately, data collection was incomplete for this assessment since some students who presented did not turn in a works cited page with their problem-solving outlines. Figure 2 presents, from the data available, percentages of each type of source as well as primary sources used. Table 5 shows percentages for each group. Based upon the limited data, Group A acquired most of their information from the Internet, periodicals, encyclopedias and books, respectively. Seventeen percent of their materials were primary sources. Group B had more varied resources, acquiring most of their information from the Internet, while using books, periodicals and pamphlets equally, with few encyclopedia sources. Eighteen percent of their materials were primary sources. Group C also acquired most of their information from the Internet, but used many more encyclopedia and periodical resources than the other two groups, followed by books and pamphlets. Only seven percent of their materials were primary sources. It should be noted that more students submitted works cited pages for evaluation from Group C, therefore there was more data for evaluation from this group.

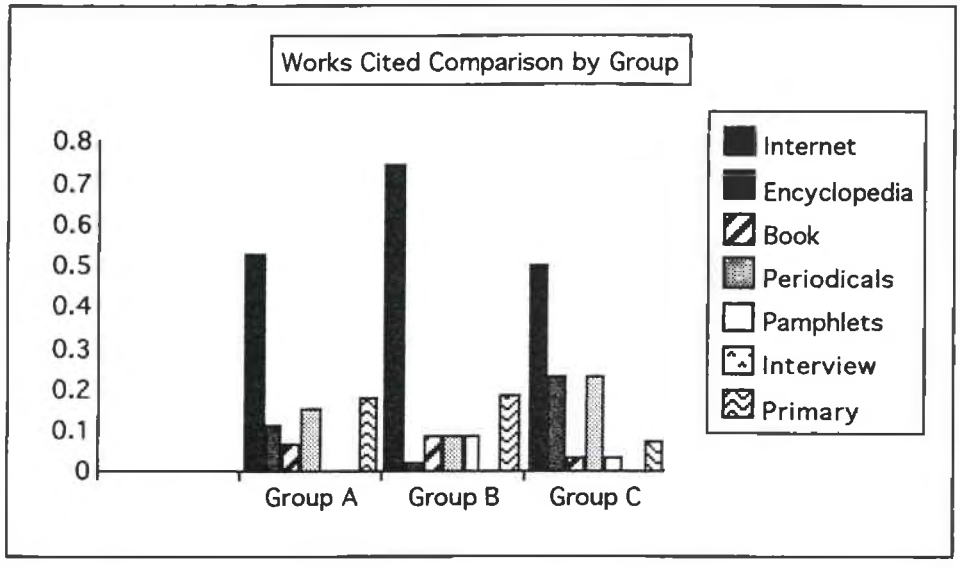

Figure 2. Works cited comparison by group reveals large Internet usage by all groups. Groups A and B report more primary source materials, while group C reflects more encyclopedia use.

Table 5

Types of Sources in Works Cited Pages in Percentages by Group

Group	Internet	Encyclopedia	Book	Periodical	Pamphlet	Primary
A	52	11	7	15	0	17
B	74	2	8	8	8	18
C	49	23	3	23	3	7

Note. Not all students submitted works cited pages for review.

Observations

The author, while assisting, observed students working throughout the research process. Specifically, the author observed the student's reaction to the research, looked at the questions, observed the key-word searching methods employed by the students, and recorded comments as they worked. In spite of their similarities in science and library knowledge, the three groups were very different in regard to their attitudes about the project and behavior during research.

Although all three classes began with the same number of students, Group A was the smallest group at the time of the study due to withdrawals and excessive absences (truancy, disciplinary measures, etc.) Although 27 subjects participated in pretesting, by the time the research process began, there were only 20 remaining. Because of the small number of students, there was little competition for resources. Students were able to utilize the computer stations without much wait. Student attitudes were pleasant, and the students were attentive during explanations and lessons. An initial check of prepared research questions revealed that about 1/4 of the students had questions for research. These students were permitted to begin research, while others were instructed to write questions and have them checked before proceeding. Students willingly complied and began working. Students in Group A employed some of the more sophisticated keyword search techniques only when simple searches produced few results and after being prompted to do so. Students in this group were on task and printed much material quickly, taking time to read the information later. Questions were simple, closed in nature, and answered fairly quickly. Students in this group had to be reminded about the visual aid and the works cited requirements on the last day of research. Only one of the

students in this class came in for extra research during a study hall period. Students were less diligent on the last day in the library. Some comments from this group revealed that even though some students were working on other homework assignments, they did not have enough time to complete the research before presenting. A few indicated some frustration that they could not find easy solutions to their problems.

Group B was the most difficult group with which to work. The students in this group sat at tables in cliques on the first day and stayed with their groups throughout the duration of the project, although this was not supposed to be a group effort. Students in this group entered the library with a negative attitude toward the assignment. They were not attentive during instructional time, and were more anxious about starting research. Again, only about 1/4 of the students were prepared with questions for the first research period, but resented having to write questions before beginning. Some sat the entire period without completing their questions, thereby losing an entire day of research.

There were 25 students in this group, which resulted in more competition for resources. Even though students were reminded to share the computer stations, the same students sat down at the computers the next day, with no argument from those who were unable to get a station the day before. Much teacher/student interaction involved trying to get students on task. Students in this class did not print as many materials, and did not print quickly. However, their questions were more open-ended, and they spent more time with the sources looking for answers before printing. These students followed Carol Kuhlthau's model more closely, taking time to read and evaluate sources for content as they worked with the sources (Kuhlthau 1993). Unfortunately, this resulted in frustration on the part of students waiting for materials.

Students in this group employed sophisticated keyword searching strategies when necessary, yet some resented prompting to do so. On the day that they were required to evaluate their research progress and revise or prepare new questions, they seemed resentful of the interruption. However, many of them seemed to be doing a fair job with the assignment. Comments revealed that they were frustrated when the answers to their questions did not appear quickly. There were many comments that indicated there was not enough time, not enough computers, too many interruptions, and most often that there was not enough information on their topics. Some students in this group did not want to spend time looking for pictures or graphs for their visual aids, and were resistant about preparing the works cited page. On the last day there was a feeling of frustration by some students, and the students who had given little effort early in the research were now anxious to complete the requirements. Six of the students in this class came in to work during lunch, study hall, and after school in order to complete the assignment.

Students in this group seemed to fit the pattern of reluctant researchers described by Burdick, who reported on patterns of learning style among students conducting research. Students in Group B took longer to become interested or involved in the learning, and some never became engaged in their research (Burdick 1996). Of the 25 students who participated from this class, seven chose not to make final presentations, receiving a score of 0 for the assignment.

Group C was by far the most interested in the project. They had a pleasant attitude, and seemed to be genuinely happy to be in the library. This was also a large group with a great deal of competition for the computer resources. They busied themselves with books and other sources while they

waited. Some paired up to wait by the computer for their turn as soon as another student was finished, and in some cases helped one another find materials. They asked to be reminded about the keyword searching techniques when they were frustrated with simple searching, and asked for help often. They printed a great deal of information, and like Group A, printed quickly, waiting to read for content later. These students used many more sources than the other two groups. By the last day, most of the students were working at their tables, with fewer students on computers. Two of the students came in during study hall time at the end of the assignment because they later realized they did not have enough information to complete the problem-solving outline. Students in this group used more encyclopedia sources, and many of these were from home computers, indicating they worked on this project on their own time. They had to be reminded to prepare a visual aid, but seemed comfortable with the works cited requirement. There were fewer complaints in this group, and comments seemed to be related to the content rather than the assignment, itself. All students from Group C participated in the research, and only one elected not to make a presentation. Although this group received the least instruction, more of the students in this group were engaged in their research and fit the description of the involved learner described by Burdick (1996). This interest positively affected the outcome of their research.

Attitude Survey Results

The attitude survey scores were tabulated for each student, with a maximum positive score of 30. Means and standard deviation were calculated for each group as presented in Table 6. Survey results indicate that Groups A and C had the most positive attitude regarding the research experience which matches the observations of the author. Responses to questions one through

six were calculated with percentages of positive, undecided, and negative responses for each group. Percentages are reported in Tables 7, 8, and 9.

The first three statements were worded such that responses of Strongly Agree and Agree were tabulated together as positive responses. Statement one dealt with selecting a topic of interest for the assignment. All groups recorded a positive response to this question, with Group A scoring the highest percentage of positive responses.

Statement two concerned knowledge of which sources to use for the assignment. All groups recorded higher positive responses to this statement, with Group C scoring the highest percentage. Group A noted a rather large 36% negative response to this statement.

Statement three dealt with knowledge of how to find information in the library and the ease with which information was found. Groups A and B recorded mostly positive responses to this statement, while Group C recorded the same percentage of positive and negative responses.

The next three statements were worded such that responses of Disagree and Strongly Disagree were tabulated together as positive responses. Statement four dealt with feelings of confusion about the kind of information needed for the project. Group A recorded the only high percentage of positive responses to this statement, with 64 percent of the students disagreeing with the statement. Sixty-three percent of the respondents in Group B and 38 percent in Group C felt confused about the type of information required.

Statement five dealt with knowing how to organize information found after research. Results for Groups A and B reflect a higher percentage of students were not confused about how to organize the information, while Group C indicated a higher percentage of students were unsure about how to organize

their information. A lack of research preparation or focus may have caused these responses since Group C received less instruction.

Statement six concerned the students' understanding of the expectations of the project. Percentages for Groups A and B reflect that those students did not fully understand the expectations of the project, while Group C had an equal number of positive and negative responses to this statement. These responses are interesting since both the instructor and media specialist believed the expectations were very clearly stated, with the instructor preparing his own presentation as an example for them to follow.

Table 6

Mean and Standard Deviation of Attitude Survey Results by Group

Group	M	SD
A	20	4.1
B	19	4.3
C	20	4.6

Note. Possible positive score of 30.

While the responses to the first six statements provided some insight into the research attitudes of the participants, responses to the open-ended question more closely match the observations of the author. Question seven asked the participants to describe their feelings at the beginning, middle, and end of the research process. These comments, arranged by group, are available in Appendix G. Group C had the most positive comments regarding their research process, while Group B, as predicted, was the most negative.

There were a total of 17 responses from Group A. Four students volunteered that they were happy with the research assignment, while one indicated boredom. Two students in this group indicated they needed more time in order to complete the assignment. Five indicated difficulty finding information on their topics, while two revealed that there were sufficient sources on their topic. Only one indicated confusion regarding where or how to start the research process. One student indicated difficulty organizing the information after it was located. Several indicated confusion at first, but indicated forming a focus after further research, supporting findings by Kuhlthau (1985). One student reported, "At first I did not understand what to do, but after looking on the computer I found many resources. Then I felt I could put it all together for my project. When I finished I was pretty sure I did well."

There were 21 responses to question seven from Group B. Five students indicated that they disliked library research. Comments ranged from, "It [the assignment] was stupid and a waste of class time," to "I hated it. I hate doing research on things that don't interest me." Four students responded that they had difficulty finding information on their topics, while two indicated that there was sufficient information on their topics. Two reported that they needed more time for research. Two students indicated that they were lost throughout the

process. One had difficulty organizing the information, while another reported confusion regarding expectations of the assignment. Some comments supported Carol Kuhlthau's discussion of the feelings experienced during various stages of research (Kuhlthau, 1985). For example, two students indicated feeling frustrated at the beginning, but feeling more comfortable as they were able to find information and locate a focus. Additionally, two students revealed they successfully reached the final stage of closure described by Kuhlthau (1985) when they indicated that they researched until they were unable to locate "new" information. One comment from this class particularly reflected Kuhlthau's study of the research process, and fit the pattern of a thoroughly engaged learner (Kuhlthau 1993). "It should be easy in a sense, because you have encyclopedias, Info Trac, magazines, Internet which has as much information as one person needs. I thought it was interesting. I got to learn about new stuff I never even had a clue of. Everyday I learned more and more until I couldn't find anything else on my topic." Unfortunately, this attitude was not shared by many others in Group B.

There were 24 students who responded to question seven from Group C. Many indicated that they enjoyed the project and several stated that the library resources were helpful. Seven students indicated feeling lost or confused at first, but then more comfortable as they progressed, which would suggest that they were finding their way through the research process described by Kuhlthau (1993) without the instructional guidance provided to Group B. Only one mentioned that there was not enough time to complete the task, while three indicated there was not enough information on their topics. A few indicated they were confused or did not understand the expectations of the assignment. As previously stated, more students in this group were involved and engaged in

their research. One student reported, "I feel that I thought the project was going to be hard until I got the information explaining how to do this, and how he wanted it laid out. After a few days it was easy and I found everything I needed okay. When I finished the project I thought I succeeded because I knew I had all of the info I needed to have in order to get a good grade."

Table 7

Research Attitude Survey Expressed in Percentages for Group A

Statement	Positive Response Strongly Agree/Agree	Undecided	Negative Response Disagree/Strongly Disagree
I was able to select a topic of interest for this assignment.	72%	18%	9%
I knew which sources to use and felt comfortable researching this topic using the library's resources.	41%	14%	36%
I know how to use the resources in the library to find information about my topic, and found information easily when researching.	45%	27%	27%

Statement	Positive Response Disagree/Strongly Disagree	Undecided	Negative Response Strongly Agree/Agree
I felt confused and did not understand what kind of information I should find about my topic.	64%	14%	23%
I felt unsure about how to organize the information I found after researching in the library.	55%	9%	36%
I did not understand what characteristics were expected in order to make this project successful or to receive a good grade.	27%	27%	45%

Table 8

Research Attitude Survey Expressed in Percentages for Group B

Statement	Positive Response Strongly Agree/Agree	Undecided	Negative Response Disagree/Strongly Disagree
I was able to select a topic of interest for this assignment.	67%	8%	25%
I knew which sources to use and felt comfortable researching this topic using the library's resources.	54%	25%	21%
I know how to use the resources in the library to find information about my topic, and found information easily when researching.	46%	29%	25%

Statement	Positive Response Disagree/Strongly Disagree	Undecided	Negative Response Strongly Agree/Agree
I felt confused and did not understand what kind of information I should find about my topic.	33%	4%	63%
I felt unsure about how to organize the information I found after researching in the library.	50%	17%	33%
I did not understand what characteristics were expected in order to make this project successful or to receive a good grade.	29%	17%	54%

Table 9

Research Attitude Survey Expressed in Percentages for Group C

Statement	Positive Response Strongly Agree/Agree	Undecided	Negative Response Disagree/Strongly Disagree
I was able to select a topic of interest for this assignment.	69%	23%	8%
I knew which sources to use and felt comfortable researching this topic using the library's resources.	58%	23%	19%
I know how to use the resources in the library to find information about my topic, and found information easily when researching.	69%	15%	15%

Statement	Positive Response Disagree/Strongly Disagree	Undecided	Negative Response Strongly Agree/Agree
I felt confused and did not understand what kind of information I should find about my topic.	27%	27%	38%
I felt unsure about how to organize the information I found after researching in the library.	27%	23%	50%
I did not understand what characteristics were expected in order to make this project successful or to receive a good grade.	38%	23%	38%

CHAPTER V

DISCUSSION

Summary

Information literacy, the ability to access, evaluate, and use information from a variety of sources, has become one of the most important skills our students must acquire in order to be successful in the Information Age. Current educational library theory supports problem-solving research process approaches as the best methods for developing information literacy, however few studies have actually tested their effectiveness. This study was designed to compare the effectiveness of three methods of library skills instruction using subjects from three high school science classes. The quasi-experimental control group design was used to determine if students in Group B, who were taught using the *Big Six Information and Problem-Solving Skills* model, would demonstrate a better knowledge of information literacy and have a more positive research experience than Group A which was taught using a modified process approach that omitted the evaluation stages, or Group C, which was only taught location and access skills.

Eleventh and twelfth grade students enrolled in three Science Technology and the Environment classes at Tecumseh High School were the subjects of the study. Students were pretested in regard to their environmental science knowledge and library research skills prior to participating in the research assignment. Students conducted research and, using a problem-solving outline, prepared oral presentations which were evaluated using rubrics prepared by the experimenter for a post evaluation. Composite scores, as well as works cited pages, were analyzed. Qualitative data from the author's observations and student survey responses were recorded and discussed.

Conclusions

Although students in Group B performed slightly better than the other two groups on the post assessment presentations, the results were too close to be conclusive that students who were taught the *Big Six Information and Problem Solving* model demonstrated more information literacy. Furthermore, the students in Group B did not appear to have a more positive research experience than students in the other two groups. Based upon the responses to the survey and the observations of the author, these students had the least positive experience of all three groups. In fact, according to the survey results and observations, the group who received the least instruction demonstrated the most positive attitude toward the research process. This result may not, however, be related to the approach, but rather reflects the negative or positive attitude regarding research displayed by the groups before the experiment started.

Tracey Burdick (1996) identified learning styles among participants in their studies of high school students conducting research for class assignments. Based upon the students' evaluation of their involvement with their topics, they were identified as involved, detached, or reluctant researchers. Clearly the students who were involved demonstrated information literacy and an interest in doing more research. While some of the detached and reluctant researchers were able to form a focus and successfully complete a research assignment, they did not enjoy the experience, and may never really become involved in further research for class assignments or their own personal gain. Many of the students in Group B of this study seemed to fit the detached or reluctant learning styles.

Some of these students remained detached and lost, as evidenced by the large number who did not complete the project, while others were able to find some success. It is possible, but not conclusive, that the *Big Six Information Problem Solving* model may have helped guide them successfully through this assignment.

Students in Group C, on the other hand, were largely involved and engaged in their research. Although they were only told where and how to access sources, students in this group were predominately successful, surpassing students in Group A who received the modified process approach. It is apparent from comments made on the attitude survey, that although the process approach was not formally presented to Group C, many of these students developed a process approach anyway. This would indicate that some students, particularly those thoroughly engaged in their research, can navigate themselves through the process, while others may require more guidance and structure in all phases. It is apparent that involvement and interest in the research plays an important role in information literacy.

It is more difficult to draw conclusions regarding Group A, whose composite scores were the lowest of the three groups. These students were as pleasant as those in Group C, but did not seem as engaged. As previously stated, some of these students worked on other assignments instead of the research during time allotted for library research. While they did not indicate that they hated research like several of the students in Group B, some were detached and unmotivated by the experience.

Recommendations

Based upon the information gathered from this research, the author would like to make several recommendations. Students in this study were pretested to determine their knowledge of library research skills in a variety of areas. The low scores on this test, as well as their apprehension regarding research indicate that students need many more opportunities to research and gain information literacy skills. Furthermore, because attitude and interest seemed to play a large role in the acquisition of skills, students must be encouraged to explore topics of their own choice in hopes of encouraging them to become involved and engaged in their research. According to Kuhlthau (1985), anxiety at the beginning of the research process is a normal feeling that subsides as students research and form a focus. Teachers and library media specialists should prepare students for the feelings common in research while guiding them through a recognized process approach.

Additionally, in order to maximize the experience for students, library media specialists need to provide quantities of varied resources for students and teach them to use them effectively. Team teaching should be encouraged, with the library media specialist assisting the classroom teacher in the planning of the research unit. The teacher and media specialist should carefully plan the unit so that all students have sufficient class time for exploration, taking care that all students have an opportunity with necessary sources. Students should be encouraged to read for pertinent content before printing large amounts of information, but finding ways to ensure that all students have an opportunity to use the materials can be difficult. Teachers and library media specialists must explore ways to encourage equitable use of resources.

While no conclusive evidence was found that the *Big Six Information Problem Solving* model was the most effective approach in developing information literacy, it did appear that it helped guide some reluctant researchers through a moderately difficult problem solving assignment. This author recommends its use, while acknowledging that further studies using larger samples may be indicated to support this opinion. In addition, the employment of the motivational techniques described by Burdick (1998) should be explored for their merits in enhancing involvement in the research process.

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Appendix A

Problem Solving Outline

PROBLEM SOLVING

The following environmental problem does exist. We will be giving you various bits of information about the problem to help you make decisions concerning this problem. The idea here is to learn how to use the problem solving model and look at information from various standpoints. Like most environmental problems there is not just one correct answer . as we go through this model, please ask any questions you may have.

I define the problem

"gather information"
In a few sentences state what you believe the problem is in this situation.

_____

_____

_____

_____

(note) now would be a good time to review the "values" listed below as a way to look at the good and bad points of the problem.

VALUES

AESTHETIC
ECONOMIC
ENVIRONMENTAL
EDUCATIONAL
ETHICAL/MORAL
HEALTH
RECREATIONAL
SCIENTIFIC
SOCIAL/CULTURAL
LEGAL
EMOTIONAL
POLITICAL

IMPACT STATEMENT WHAT ARE THE GOOD POINTS AND BAD POINTS OF THE PROBLEM . 1IST THESE IN THE SPACE BELOW. LIST AT LEAST 4 GOOD AND 4 BAD POINTS FOR EACH.

GOOD POINTS	*BAD POINTS*
1.	
2.	
3.	
4.	
5.	
6.	

HOW PRESSING?

1. WHAT INFORMATION DO YOU HAVE WHICH WILL HELP DETERMINE HOW FAST THE PROBLEM NEEDS TO BE SOLVED?_____

2. WHAT INFORMATION COULD YOU GET TO HELP YOU ESTABLISH A DEADLINE FOR ACTION. ?

3. HOW SOON DOES THIS PROBLEM NEED TO BE SOLVED ?

II PROPOSE SOLUTIONS

"EXPLORE CONSEQUENCES"

1.

2.

3.

III FIND THE MOST APPROPRIATE SOLUTION

"MAKE A DECISION"

BASED ON EVIDENCE CHOOSE THE MOST APPROPRIATE SOLUTION FROM THE ONES LISTED ABOVE, OR COMBINE SOLUTIONS TO COME UP WITH WHAT YOU THINK WILL BE THE MOST EFFECTIVE SOLUTION.

IMPACT STATEMENT ON SOLUTION

GOOD POINTS	*BAD POINTS*

ARE YOU SATISFIED WITH YOUR SOLUTION WHY OR WHY NOT?

CAN YOUR SOLUTION BE PUT INTO EFFECT?

WHAT WOULD YOU HAVE TO DO TO PUT YOUR SOLUTION INTO EFFECT? STATE WHAT STEPS YOU WOULD HAVE TO TAKE TO ACTUALLY PUT THIS INTO PRACTICE. WHO WOULD HAVE TO TAKE RISKS? WHAT LAWS WOULD HAVE TO BE CHANGED? HOW MUCH MONEY WOULD IT COST ? ETC. BE AS SPECIFIC AS POSSIBLE HERE.

IS YOUR SOLUTION IN TIME?

EVALUATION ARE YOU SATISFIED WITH THE NET IMPACT OF YOUR SOLUTION AND HOW IT CAN BE PUT INTO EFFECT? DOES IT MEET THE TIME LINE? COULD THE TIME LINE BE ALTERED TO BE MORE REALISTIC AND BE ACCOMPLISHED BY THIS SOLUTION?

Appendix B

Library Research Pretest

Library Research Pretest

Select the response that best answers the question or completes the sentence.

1. Which of the following items are **not** required when citing a book source?

   a. date it was published **b.** the author **c.** the date you read it
   d. where it was published **e.** all are required

2. A Works Cited page includes all sources listed in what order?

   a. alphabetically **b.** in order of reference in the project **c.** prioritized by the importance of the source **d.** according to the date of the source

3. Ideas of an author should be cited

   a. only if directly quoted **b.** if they are included in the project **c.** only if you do not agree with them **d.** only if not directly quoted

4. When citing an Internet source, which of the following should **always** be included in a Works Cited page?

   a. number of pages or screens **b.** the WWW address of the site **c.** date you found the source **d.** both b and c **e.** both a and b

5. Which of the following is an example of a primary source?

   a. weather data **b.** a weather forecast **c.** a diary entry written by Madame Curie **d.** both a and c **e.** both a and b

6. Which of the following is an example of a secondary source?

   a. photograph of pollution in a lake **b.** magazine article comparing the pollution levels in Lake Erie to those in Lake Michigan **c.** an encyclopedia article describing the wildlife in the desert **d.** both b and c **e.** all of the above

7. Which of the following sources are acceptable for research purposes?

   a. encyclopedias **b.** magazine articles **c.** interviews **d.** a and b only
   e. a, b, and c

8. Which of the following sources is the **most acceptable** for research purposes?

a. unsigned Internet article **b.** magazine article describing a scientific experiment **c.** student research report published on the Internet **d.** a and b **e.** a, b, and c

9. A student is looking for information on pollution and its effects on marine wildlife in Lake Erie. What is the **best** combination of key words for her search?

a. pollution and wildlife and Lake Erie **b.** pollution and marine **c.** pollution and Lake Erie **d.** marine and Lake Erie **e.** all of the above

10. A student is looking for information on the industrial revolution in the United States. What is the **best** combination of key words for his search?

a. industrial revolution **b.** revolution and United States **c.** industrial revolution and United States **d.** b and c **e.** a and c

11. InfoTrac is used to find what type of sources?

a. periodicals **b.** books in the library **c.** newspapers only **d.** primary sources **e.** a and b only

12. The online catalog is used to find what type of sources?

a. World Wide Web sites **b.** periodicals **c.** books in the library **d.** primary sources **e.** all of the above

13. The Readers' Guide to Periodical Literature is used to find what type of sources?

a. vertical file information **b.** magazine articles **c.** books **d.** a and b only **e.** all of the above

14. A student is writing a report on the desert biome. Of the choices below, select the **best** set of main ideas that should be covered on this topic?

a. characteristics of a desert **b.** plants of the desert **c.** animals of the desert **d.** plants and animals of the desert **e.** a, b, and c

15. A student is researching information about President Clinton's recent visit with Boris Yeltsin. What is the **quickest** way to locate this type of information?

a. encyclopedias **b.** InfoTrac **c.** browsing recent newspapers **d.** both b and c **e.** all of the above

16. A student wants to locate a photograph of Diana, Princess of Wales. What is the **best** source for finding the photo?

a. Internet **b.** InfoTrac **c.** newspapers **d.** online catalog **e.** all of the above

17. A student has located an Internet site on volcanoes. What is the **most important** criteria she should use to determine if the source is appropriate?

a. the credentials of the author **b.** that the material is based on solid facts **c.** the date it was published **d.** both a and b **e.** a, b, and c

18. When taking notes from research sources, students may **paraphrase** information by

a. restating the information in the student's words **b.** quoting the exact words of the author **c.** changing a few large words the student doesn't understand **d.** copying and pasting larger amounts of information directly into a word processing document. **e.** all of the above

19. Students know their research is complete when

a. the due date arrives **b.** they cannot find any more new information on the topic **c.** most questions are answered **d.** a book doesn't have any information on the topic. **e.** b and c

20. A student cannot locate a book specifically about the Battle of Bull Run. He does, however, find a book about battles of the Civil War. How would he find out if the book contains information about Bull Run?

a. skimming each chapter **b.** the table of contents **c.** the index **d.** skimming the chapter titles **e.** there is no way to know without reading the entire book

Appendix C

Test of Environmental Understanding

Test of Environmental Understanding

1. You pick up a bottle with an NFPA hazard diamond. The blue color indicates which hazard?
a. fire
b. reactivity
c. health
d. other specific hazard

2. In the laboratory broken glass should be disposed of how?
a. put it in the trash can
b. wrap up in newsprint and dispose of in janitors large trash can
c. leave in place for instructor to dispose of
d. place unwrapped in the glass only can by the sink

3. The term which describes the thin layer of life around the world from the surface of the earth to approximately 8 km above and below the oceans surface is ?
a. biosphere
b. atmosphere
c. hydrosphere
d. lithosphere

4. The root of all environmental problems can be traced to two problems consumption crisis and ?
a. pollution crisis
b. predation crisis
c. education crisis
d. population crisis

5. Environmental science is classified as
a. pure science
b. applied science
c. non-science
d. biology

6. Most of the world population is found in which category?
a. USA/Canada/western Europe
b. China
c. Former Soviet Union and eastern Europe
d. developing countries

7. Using the answers above which population produces the greatest CO2 emissions?

8. In making an environmental decisions which is always the 1st critical step?
a. make a rapid decision
b. consider values
c. gather information
d. explore consequences

9. In an ecosystem which factors would include all of the following except which?
a. microorganisms
b. temperature
c. soil type
d. humidity

10. Which is an example of coevolution?
a. flower species that can only be pollinated by one insect species
b. deer that live in a cold regions and have thick fur
c. dark grey moths which live near Birmingham England
d. desert rats that do not sweat

11. From producer to secondary consumer how much energy is lost?
a. 10%
b. 90%
c. 99%
d. 100%

12. Which is not true of consumers?
a. They get energy indirectly from the sun
b. they are heterotroph
c. they make their own food
d. they may eat other consumers

13. Which is correctly arranged from the lowest to the highest trophic levels?
a. bacteria, frog, eagle, mushroom
b. algae, deer, wolf, hawk
c. grass, bass, minnow, snake
d. grass, mouse, snake, eagle

14. Which is not true of the nitrogen cycle?
a. animals get N by eating plants or other animals
b. plants generate nitrogen in their roots
c. nitrogen moves back and forth between the atmosphere and living things
d. decomposers break down waste to yield ammonia

15. Which is most likely to be the pioneer organisms on an area of bare rock?
a. saplings
b. shrubs
c. lichens
d. perennial grasses

16. Which of the following best describes the policy of the National Park Service
a. put out all fires
b. wait and see if fires become dangerous before acting regardless of origin
c. allow all fires to burn which are created by nature if lives, property scenic areas, and endangered species are not threatened
d. put out no fires

17. There are how many state parks in Ohio?
a. 10
b. 53
c. 72
d. 107

18. The best policy for park visitors is
a. enjoy yourself first and foremost
b. leave only footprints and take only memories
c. Its ok to take living species if you follow the 1 to ten rule
d. follow the rules which make sense to you but don't worry too much about them.

19. The main detrimental for a biome is
a. climate
b. population
c. plants
d. animals

20. Tropical rainforests cover approximately what % of the earths surface?
a. 1%
b. 7%
c. 20%
d. 70%

21. Compared to temperate deciduous forest temperate grasslands receive?
a. same rainfall
b. sometimes more sometimes less rainfall
c. more rainfall
d. less rainfall

22. Bacteria cause eutrophication to occur in lakes that contain a large amount of plant nutrients by
a. feeding on decaying plants and algae
b. reducing oxygen dissolved in the water
c. both a and b
d. neither a or b

23. An ecosystem in which fresh water mixes with salt water form the ocean is a/an
a. delta
b. shoreline
c. river
d. estuary

24. all of the following are primary air pollutants except which?
a. ozone
b. NOx
c. SOx
d. VOCs

25. Approximately how much of our air pollution comes from gasoline in motor vehicles?
a. 10%
b. 33%
c. 75%
d. 90%

26. Which is an example of an indoor air pollutant?
a. ozone
b. SO2
c. radon
d. smog

27. Which is an example of a fuel that produces less pollution than gasoline?
a. hydrogen
b. ethanol
c. natural gas
d. all of these

28. Precipitation is considered to be acid if the pH is?
a. greater than the pH of clear rain
b. greater than 5
c. greater than 7
d. less than 5

29. All of the following are major greenhouse gases except which?
a. CO2
b. CFCs
c. methane
d. H2O

30. CO2 makes up what approximate percentage of the atmosphere?
a. 0.03%
b. 3.00%
c. 30.00%
d. 97.30%

31. Which is not an adverse effect of high levels of UV light?
a. increased incidence of skin cancer
b. increased photosynthesis
c. disruption of the oceans food chains
d. increased amount of atmospheric CO2

32. The number and variety of species on earth is known as what?
a. ecology
b. extinction
c. biodiversity
d. biota

33. The Florida Panther is an example of a species on the verge of extinction primarily because?
a. lack of genetic diversity
b. habitat destruction
c. lack of food
d. pollution

34. Some species are so important to the functions of an ecosystem that they are called?
a. threatened species
b. endangered species
c. extinct species
d. keystone species

35. Approximately what percentage of prescription drugs were derived from living things?
a. 10%
b. 20%
c. 40%
d. 90%

36. By emphasizing the preservation of entire ecosystems
a. Insect resistant peaches can be developed
b. unknown species can be saved from extinction
c. the health of the biosphere will be jeopardized
d. biodiversity will be decreased

37.If 37 mammals were listed on the endangered species list in 1992 but 57 birds were listed, the percentage of the mammals which make up the total list if the total list contained 160 organisms?
a. 10.3%
b. 23.1%
c. 39.6%
d. 86.6%

38. Which division in the US makes up the greatest amount of energy use?
a. electrical generation
b. industry
c. transportation
d. other

39. Most electrical energy in the US comes from which power source?
a. nuclear
b. water
c. oil and gas
d. coal

40. The fuel in nuclear fission which powers most nuclear powerplants which produce electricity is
a. U238
b. U235
c. Po239
d. Pb206

41. The only nuclear accident which was known to have taken the lives of people directly occurred where?
a. 3 Mile Island
b. Diablo Canyon
c. Shoram
d. Chernobyl

42. The biggest problem associated with nuclear fusion as a power source is?
a. cost of fuel
b. nuclear waste products
c. high temperature needed
d. low output of energy produced

43. A south facing window with an overhang is an example of what?
a. energy conservation
b. active solar energy
c. passive solar energy
d. wind energy

44. Photovoltaic cells are relatively
a. cost effective
b. energy efficient
c. versatile
d. none of these

45. Which is not a renewable energy source?
a. solar energy
b. fossil fuels
c. biomass
d. hydroelectricity

46. Manufacturers could reduce waste and conserve resources by making products that?
a. use more material
b. are more durable
c. are difficult to repair
d. are disposable

47. Which is the BEST answer to manage hazardous waste
a. incineration
b. land disposal
c. reduction of amount produced
d. conversion to non-hazardous substances

48. Microorganisms are unable to break down plastics because?
a. plastics are too strong
b. plastics are too abundant
c. plastics are made of elements not found in any other substance
d. plastics do not occur in nature

49. The number of superfund cleanup sites in Ohio is approximately?
a. 12
b. 15
c. 26
d. 38

50. The function of an environmental impact statement is
a. to clarify the effect that a project would have on the environment.
b. to generate a record of the ongoing impact to the environment of existing structures
c. to satisfy international legal requirements
d. to limit development to a bare minimum.

Appendix D

Research Process Model
5 Point Rubric for Completed Assignment

Research Process Model
5 Point Rubric for Completed Assignment

Indicate the number that reflects the overall quality of the written project for each of the criterion areas. If the student's work reflects all of one level, but not completely at the next level, the score can be given a fraction of .5. (For example, a student score could be indicated as a 3.5.)

Works Cited

5. The student demonstrates a clear understanding of how to accurately prepare a Works Cited Page.
   The student demonstrates the ability to paraphrase and cite ideas as well as direct quotations.
   The student provides an adequate number and variety of sources, limiting general information sources such as encyclopedias.
   The student uses current sources of information, including periodicals and appropriate Internet sources.
   The student includes primary sources as appropriate.

4. The student demonstrates an understanding of how to prepare a Works Cited page, but has some minor errors.
   The student cites direct quotations, but may include too many direct quotations.
   The student is beginning to understand how to paraphrase, but needs further direction.
   The student provides some variety of sources, with a limited number of encyclopedias.
   The student uses a mixture of current and dated sources.

3. The student generally understands how to prepare a Works Cited Page, but omissions are apparent.
   The student inconsistently cites ideas and quotations.
   The student shows less care regarding currency and quality of sources.

2. The student includes a Works Cited Page, but much of the Works Cited information is incorrectly noted.
   The student inconsistently cites ideas, and quotations appear to be included without citation.
   The student provides some sources, but many are dated or too general in nature.

1. The student may or may not include a Works Cited Page, but there are many errors.
   Many instances of ideas without proper citation are apparent.
   Few, if any, sources are noted.

Content

5. The student answers all questions and presents a thorough overview of the topic at hand.
   Specific details are present and reflect that the student effectively understands key word searching.
   Sufficiently narrowed thesis or main idea is clearly stated.
   Student provides at least three main points to support the thesis.
   Student provides adequate examples of all major points covered.
   Information is accurate, current, and logically presented.

4. The student answers the questions and presents an overview of the topic.
   Some details are presented.
   A thesis or main idea is stated and main points for support are included.
   A few examples to support major points are apparent.
   Information is accurate and current, but may not be as logically presented.

3. The questions are somewhat answered, but topic is not covered as clearly as it should be.
   The thesis is stated, but may not be as focused.
   There are fewer corroborating details to support the thesis, and may not be logically presented.
   Information may not be current or may not be specific enough.

2. The thesis is poorly stated and is fairly unfocused.
   Many questions are left unanswered
   Few details are used to support main ideas, and there is little logic to its presentation.
   Information is not current.

1. There is little or no apparent focus. The student has not narrowed from the basic topic.
   There is little evidence of research, and little supporting data.
   Currency of sources may be unknown.

Presentation

5. The presentation is well organized and well focused on the topic. A clear outline is obvious, and the presenter emphasizes major points.
   The visual aid is attractive and enhances the project.
   The presenter involves the audience gets the attention of and involves the audience, using good eye contact.
   The presenter is easily understood, uses a loud and clear voice.
   The presenter explains sources of direct quotes or statistics.
   The problem and solution are clearly stated.
   The speaker stays within the time frame and uses time effectively.

4. The presenter demonstrates organization and focus.
   The visual aid is attractive and enhances the project.
   The speaker uses a clear voice and is interesting.
   The problem and solution are clearly stated.
   The student uses time effectively.

3. Some focus and organization are evident, but not all data is logically presented, or is not explained effectively.
   There is a visual aid, but it does not effectively enhance the project.
   The speaker is sometimes difficult to follow.
   The speaker does not engage the audience.
   The problem and solution are not clearly stated.

2. The focus and organization are weak.
   There are insufficient details to explain the problem.
   The visual aid is weak or unattractive.
   The presentation is too short.
   The speaker does not use eye contact.

1. There is no focus or organization.
   The problem and solution are not clearly stated.
   There is little supporting data.
   There is no visual aid.
   There is no eye contact.
   The presentation is too short.

Appendix E

Research Attitude Survey

Research Attitude Survey

Circle the answer that best describes how you felt regarding this research assignment.

1. I was able to select a topic of interest for this assignment.

Strongly Agree Agree Undecided Disagree Strongly Disagree

2. I knew **which** sources to use and felt comfortable researching this topic using the library's resources.

Strongly Agree Agree Undecided Disagree Strongly Disagree

3. I know **how** to use the resources in the library to find information about my topic, and found information easily when researching.

Strongly Agree Agree Undecided Disagree Strongly Disagree

4. I felt confused and did not understand what **kind** of information I should find about my topic.

Strongly Agree Agree Undecided Disagree Strongly Disagree

5. I felt unsure about **how** to organize the information I found after researching in the library.

Strongly Agree Agree Undecided Disagree Strongly Disagree

6. I did not understand **what** characteristics were expected in order to make this project successful or to receive a good grade.

Strongly Agree Agree Undecided Disagree Strongly Disagree

7. Describe your feelings when doing library research (consider how you felt when you began, after a few days, and when you finished your research).

Appendix F

Lesson components for Groups A, B, and C

Lesson Components for Groups A, B, and C

Group A
Modified Process Approach

1. Students will receive an introduction to the topics to be explored and will make topic selections.
2. Students will receive and discuss problem-solving outline with teacher.
3. Media Specialist will begin instruction on features and accessing of various sources. A suggested research chain will be distributed.
4. Media Specialist will discuss citing sources and distribute a handout of examples using the MLA style.
5. Students will make a list of questions to be explored about their topic. (Minimum of 5)
6. Students will make a list of sources to use, and will be encouraged to use a wide variety of sources. Students will be encouraged to paraphrase information and should be looking for answers to their questions.
7. Media Specialist will discuss primary and secondary sources and will discuss evaluating WWW sources.
8. Students will continue with research, completing the problem-solving outline, keeping notes, outline, and questions in folder.
9. Media Specialist will review outline notes while students work.
10. Students will complete problem-solving outline and prepare visual aid for presentation.
11. Teacher will give sample problem-solving presentation with class discussion following.
12. Students will give presentations and complete attitude survey.

Group B
Big Six Approach

1. Students will receive an introduction to the topics to be explored and will make selections.
2. Students will receive and discuss problem-solving outline with teacher.
3. Media Specialist will begin instruction on features and accessing of various sources. A suggested research chain will be distributed.
4. Media Specialist will discuss citing sources and distribute a handout of examples using the MLA style.
5. Students will make a list of questions to be explored about their topic. (Minimum of 5)
6. Students will prepare a prioritized list of sources to use and begin initial research, working from general sources to more specific. Students will take notes, paraphrasing information, and look for answers to their questions.
7. Media Specialist will discuss primary and secondary sources and evaluating WWW sources.
8. Students will continue with research, completing the problem-solving outline, evaluating the research and the sources, looking for holes or weak areas and new questions to be explored. Notes will be kept in a journal.
9. Media Specialist will review journal notes while students work.
10. Students will complete problem-solving outline and prepare visual aid for presentation.
11. Teacher will give sample problem-soliving presentation with class discussion following.
12. Students will give presentations and complete attitude survey.

Group C
Access Skills Only Approach

1. Students will receive an introduction to the topics to be explored and will make selections.
2. Students will receive and discuss problem-solving outline with teacher.
3. Media Specialist will begin instruction on features and accessing of various sources. A suggested research chain will be distributed.
4. Media Specialist will discuss citing sources and distribute a handout of examples using the MLA style.
5. Students will be instructed to use a wide variety of sources and will begin searching using key words. Students will be encouraged to paraphrase information when taking notes.
6. Media Specialist will discuss primary and secondary sources and will discuss evaluating WWW sources.
7. Students will continue with research, completing the problem-solving outline, keeping notes in folder. Students will be reminded to ask for help if needed and to use a variety of sources.
8. Media Specialist will review notes and outline while students work.
9. Students will complete problem-solving outline and prepare visual aid for presentation.
10. Teacher will give sample problem-soliving presentation with class discussion following.
11. Students will give presentations and complete attitude survey.

Appendix G

Attitude Survey Comments for Groups A, B, and C

Group A
Attitude Survey Comments

"I wish we had more time to do it."

"I didn't know where to start."

"I did Mammoth Cave and there wasn't that many 'problems", they were hard to find. It was easy to organize the information with the problem solving outline."

"It was fine!"

"I could not find any information on my subject. I went every class time to the library and went on computer and could not find anything I wanted. That is why I didn't have a lot of information to say on my project."

"When doing library research I feel as though I can't always find what I'm really looking for. I never really got to finish my research."

"It didn't bug me going in front of the class. I was just bothered because I didn't get enough library time because I was sick. So I thought I got a bad grade. I thought this was stupid, but that's school. I guess you just have to go with it."

"I thought it was hard because I didn't know how to look up my topic, so I couldn't get a lot of information. Or the information I thought I needed."

"I felt happy to be in the library doing work."

"At first I didn't want to do it but it kind of got interesting after the first couple of days."

"Begin--bored. Middle--still boring. I never really got to finish."

"I kicked it off pretty well. I feel I did a pretty good job on finding information and also on the whole project. When I started I didn't know what to expect, but it was all right after a while."

"On my research topic I didn't hardly find any information on my topic. I looked on the Internet, in books and magazines and even encyclopedias. I feel you need to broaden your Internet sources. AOL for instance."

"The first few days are always the easiest since all information is new. Then it gets frustrating when everything you come across you already have."

Group A
Attitude Survey Comments Continued

"I don't mind doing it."

"At first I did not understand what to do, but after looking o the compute I found many resources. Then I felt I could put it all together for my project. When I finished I was pretty sure I did well."

"Happy to be out of class, yet frustrated with my limited access of the Internet. Censorship is Communism and I am sick of it."

Group B
Attitude Survey Comments

"I had trouble organizing my material."

"I do not like library research project. They are boring and a waste of time."

"I hated it. I hate doing research on things that don't interest me. I hated all of the question papers we had to fill out during library time. I hate telling about it in front of the class even more."

"Did not completely understand what was expected."

"I don't like it."

"All I could find on the Internet about vandalism in parks was pictures, hardly any solid information."

"Frustrated at first, happy in the end."

"When we first started I thought there would be more information than what I found, so I thought it was going to be easy. After a few days when I couldn't find very much I thought I was going to be able to get it all done. When I finished I thought I did a good job with the information I had."

"When I began I felt comfortable. After a while of not finding much it got frustrating."

"I don't have any feelings about library research. But I do have feelings about all of this crap!! I do not believe that it is necessary for us as students to do your research for you! If you needed information about students find research subjects then you should observe and so on. Not give us more work that means absolutely nothing to us except making things harder to get done!!!"

"It should be easy in a sense, because you have encyclopedias, InfoTrac, magazines, Internet which has as much information as one person needs. I thought it was interesting. I got to learn about new stuff I never even had a clue of. Everyday I learned more & more until I finally couldn't find anything else on my topic."

"I felt that it was stupid and a waste of class time."

"When I started I was pretty lost. But by the end of the project I knew what I was doing."

Group B
Attitude Survey Comments Continued

"Well it was boring doing all of the research. But it was nice to be in the library. Wish we could have had more time."

"I don't like doing research in our library because there are not very many computers so I could not get a computer all that week. I was still very frustrated about my topic and did not feel I had enough time to put enough effort into it. I was not very happy with my project."

"I thought it would be fun but then once I started doing it I realized I really didn't even know what I was doing. I found little info because I couldn't figure out where to look for the info. Once it came time to present I didn't do it because I don't like getting up in front of the class.

"I didn't know who to please on this project. Mr. White and Mrs. Gulden seemed to have different requirements."

"At first I found a lot of stuff but then I couldn't find anything. But it was pretty easy."

"I was frustrated because I couldn't find anything at first."

"When I began, I was lost. After a few days, I was still lost. When I finished, I knew I was going to do poorly because I couldn't find much information on my topic."

"I don't like doing library research projects."

Group C
Attitude Survey Comments

"Never know where to start. Confused. After a few days, little better. Finished easily."

"I love doing library research! I especially love getting out of Mr. White's classroom."

"Frustrated because there was hardly any info on my topic."

"I really don't like doing research in the library. The only thing I really use for my information is the computers."

"I thought it was easy. I knew what was expected of me and my topic was not hard to find information on. I thought it was easy when I began and easy when I finished."

"I feel that I thought the project was going to be hard until I got the information explaining how to do this, and how he wanted it laid out. After a few days it was easy and I found everything I needed okay. When I finished the project I thought I succeeded because I knew I had all of the info I needed to have in order to get a good grade."

"When I first started my research I felt confused because I didn't know what to do, but as I got to spend more time in the library I started to get the hang of it."

"I felt like I was having a fun time when I began, & throughout the whole research."

"Felt good when I finished and got a good grade."

"I think that signing an Internet form that restricts what you do is crap because the Internet restrictor already does that."

"I felt pretty good about it, I just wish I would have had a couple more days to prepare really well."
"At first I did not know what to do until I saw other people do it. After that I was fine and did ok."

"At first I was confused but after a while I started to catch on."

"When I started I was a little confused because there was so much. But as I moved on it got easier. I was really glad when it was finally done and over with and out of my hair!"

Group C
Attitude Survey Comments Continued

"It was hard finding research about my topic. It took me a while until I actually found something. Library resources were helpful."

"It's sometimes frustrating when you can't find the information you need. and on the other had you can find too much information and not know how to organize it."

"I love the library. It is a good way to find information."

"I was nervous the whole time before this project was due because I tried working on it but didn't really understand what Mr. White expected for our presentation"

"I felt very confused about the project at the beginning on what I needed to find. After I finished the project I wasn't sure if I would get a passing grade, & I barely did--77%."

"I felt that I wasn't finding much, then I started going through other things and found what I needed. I was happy and glad."

"I'm confused at first until I get enough information to start writing."

"I had fun with this project!"

"I felt satisfied with my work until I got my grade. I felt I had wrong information after that."

"Frustrated because there was hardly any information on my topic."